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Summer Teacher Enhancement Institute
for Science, Mathematics, and Technology
Using the Problem-Based Learning Model

Progress Report

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The 1995 Summer Teacher Enhancement Institute (TEI), in its second year, is sponsored by Langley Research Center of the National Aeronautics and Space Administration (LaRC) and managed by Christopher Newport University. The Institute is designed to provide instruction and experiences in the topic of aeronautics. Because of their general lack of formal training in science and mathematics, TEI targeted middle and elementary teachers. Applications were solicited from teachers in the five state region serviced by LaRC. Through a competitive selection process based on their applications, fifty-nine teachers were selected to participate in the Institute and these teachers represented Virginia, West Virginia, Kentucky, North Carolina, South Carolina, Utah, Maryland, and the District of Columbia. Participants that lived more than 50 miles from LaRC were provided housing and board at Christopher Newport University.

Four faculty members worked as a team to design the curriculum, determine the schedule, and manage and evaluate the Institute. Dr. Bobbye Bartels from Christopher Newport University was Lead Teacher, Dr. Nilda Ocasio from University of Puerto Rico assisted Dr. Bartels, Vince Hale organized the technology aspect of the Institute, and Dr. Don Ball from the University of Virginia evaluated the Institute.

The Institute consisted of three, identical two-week sessions during the summer of 1995 and follow-up sessions held on three Saturdays during the 1995-1996 school year. A participant attended only one session in the summer, but was expected to attend all three follow-up sessions.

The objectives of the Institute were (a) increase participants' content knowledge about aeronautics, science, mathematics, and technology, (b) model and promote the use of scientific inquiry through problem-based learning, (c) investigate the use of instructional technologies and their applications to curricula, and (d) encourage the dissemination of TEI experiences to colleagues, students, and parents.

Problem-based learning was the instructional method the faculty used to implement the objectives. This method was used so the participants actually experienced problem-based learning and, therefore, would have a better idea about how to implement it in their classrooms. The daily schedule included presentations, tours and hands-on experiences. NASA scientists made presentations relating their area of aeronautics research to elementary and middle school curricula, and participants toured NASA facilities to observe the scientific environment of aeronautics research. Participants performed hands-on experiments dealing with aeronautics, experiments they could use in their classrooms. One entire day was spent at a local flight training facility where participants went through five stations: (a) planning a cross-country trip by plotting a course on a flight map, (b) using a flight simulator, (c) pre-flight check of the airplane with an investigation of the parts of an airplane, (d) tours of the Control Tower and Weather Station, and (e) a flight in an airplane.

Participants were given Spacelink accounts and instruction about how to use them. They learned how to access the Internet through Spacelink and through Netscape. They entered wind tunnel data into a spreadsheet and explored the results obtained. TEI participants will have access to their Spacelink accounts as long as they keep them active by using them.

Authentic assessment instruments were used to assess participants' understanding and implementation of aeronautics, problem-based learning, and technology. During the Institute participants worked in Flight Teams to develop a problem-based learning unit that used aeronautics as a vehicle for teaching mathematics and science, and the unit, or lessons from the unit, were presented to the session participants at the end of the first and last week of each session. During the 1995-1996 school year, participants are expected to design and implement such a unit in their classroom. This unit may be based on the unit developed during the summer, or it may be a completely new unit; but, the unit must incorporate aeronautics, problem-based learning, and technology.

One benefit from participation in the Institute is 3 hours of graduate credit in Physics from Christopher Newport University. In addition to attendance during the summer, graduate credit requires that participants design and implement the unit in their classroom. Furthermore, participants are to develop a portfolio that relates to their unit. Their grade for the graduate credit is based on the unit plan and portfolio.

Follow-up of the participants' implementation of aeronautics, problem-based learning, and technology will continue through the 1995-1996 school year. This will be monitored through e-mail communication, classroom observation by TEI faculty, and participants' presentations of unit plans at follow-up sessions.

Instruments to evaluate the Institute were designed by the TEI faculty, and Dr. Ball performed the formal evaluation. The instruments included pre- and posttests of confidence about teaching using aeronautics, problem-based learning and technology and on participants' knowledge of aeronautics. Each session was evaluated separately and then all sessions were evaluated together. The results of the evaluation showed that the Institute was successful in meeting all of its objectives. Participants' confidence in their ability to teach mathematics and science using aeronautics, problem-based learning, and technology showed a statistically significant increase in all areas. Their knowledge of aeronautics showed a statistically significant increase, also. Based on participants' written responses on the evaluation, the Institute was successful and participants felt it was a valuable use of 2 weeks. Many asked for additional Institutes of this kind.

Although the Institute was successful, there are areas that would make it even better.

- If one person in the NASA-LaRC Office of Education were responsible for TEI, the faculty would find it easier to organize and manage the Institute.
- The TEI faculty should have opportunities to communicate with each other prior to the beginning of the ASEE program; this would give the faculty a chance to "gel" as a team prior to TEI.

- The lead teacher for TEI must be identified early in March so that person can work closely with the Office of Education to organize the TEI.
- NASA presenters must be educated about the needs and background of elementary and middle school teachers so they can make presentations that are more appropriate for and easily used by the teachers. If a lead teacher is identified early and presenters can be contacted in the Spring, this issue can be addressed early enough for presenters to be able to make changes in their presentations.
- The TEI brochure must be changed to obtain more information about the applicant and to give the applicant clearer information about things like graduate credit, travel costs, and housing.
- It is recommended strongly that all participants be housed in a residence hall, not just the ones traveling more than 50 miles. By housing all participants in one facility, there will be better communication between participants and there will be time for evening activities that will enhance the Institute, e.g., working in groups, having guest speakers, accessing the Internet through computers at the facility.

In conclusion, the 1995 TEI was very successful and will be a good model for future institutes. The participants found the TEI to be very valuable and indicated that they would implement their experiences in their classrooms and discuss them with colleagues. The TEI faculty and participants enthusiastically recommend the continuation of this valuable and well-organized institute.

Abstracts

Ball, D. (December 1995). *Evaluation of Teacher Enhancement Institute 1995*. In Surendra N. Tiwari and Deborah B. Young (Eds.) 1995 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program. Page 62.

During the summer of 1995, I was the evaluator for the NASA Teacher Enhancement Institute. This program involved three cohorts of teachers. Each group of teachers attended a two week session at NASA Langley. As part of the evaluation each group of teachers was asked to respond to several questions prior to their participation in TEI activities. These same questions were asked again at the conclusion of the two weeks of activities. Also, the participants were asked to give their opinion on the value of several aspects of the Institute.

My responsibilities included the design and administration of the evaluation instruments, the coding and statistical analyses of the data generated for the evaluation, and the preparation of a final report summarizing the results. Additionally, feedback was supplied to the TEI faculty at the conclusion of each two week session.

Bartels, Bobbye Hoffman. (December 1995). *1995 Summer Teacher Enhancement Institute: Curriculum Design, Implementation, and Evaluation*. In Surendra N. Tiwari and Deborah B. Young (Eds.) 1995 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program. Page 64.

The 1995 Summer Teacher Enhancement Institute (TEI), in its second year, was designed to provide aeronautics experiences and instruction for elementary and middle school teachers so the teachers could use aeronautics to teach science and mathematics. Through an application process, 59 teachers were selected to participate in the Institute, representing seven states and the District of Columbia. Four faculty members worked as a team to design the curriculum, determine the schedule, and manage and evaluate the Institute.

The objectives of the Institute were (a) increase participant's content knowledge about aeronautics, science, mathematics and technology, (b) model and promote the use of scientific inquiry through problem based learning, (c) investigate the use of instructional technologies and their applications to curricula, and (d) encourage the dissemination of TEI experiences to colleagues, students and parents.

The Institute included presentations, tours and hands-on experiences. NASA scientists made presentations relating their area of research to elementary and middle school-curricula, and tours of NASA facilities were taken to observe the scientific environment of aeronautics. Participants performed hands-on experiments dealing with aeronautics, experiments they could use in their classrooms; and one day was spent at a local airport learning about pilot training. Participants were given Spacelink accounts, so they could communicate through e-mail and explore the resources on the Internet.

Authentic assessment instruments were used to assess participant understanding and implementation of their experiences. Assessment included the design and presentation of lesson plans that incorporated aeronautics and problem based learning, portfolios for aeronautics, and the development and classroom implementation of a unit on aeronautics. Follow-up of the participants' implementation of aeronautics and problem based learning will continue through the 1995-1996 school year through three means: e-mail communication between participants and each other and TEI faculty members, classroom observations, and presentations of unit plans at three follow-up sessions scheduled during the year.

Instruments to evaluate the Institute were designed by the TEI faculty and consisted of pre- and posttests of confidence and knowledge of aeronautics. Preliminary results indicate increases in participants' confidence in their ability to teach science and mathematics using aeronautics, problem based learning, and technology.

Hale, L. Vincent. (December 1995). *Three Two-Week Teacher Enhancement Institutes: Design and Implementation of the Technology and Telecomputing Component*. In Surendra N. Tiwari and Deborah B. Young (Eds.) 1995 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program. Page 78.

The Teacher Enhancement Institute (TEI), under the direction of the Center Education Programs Officer offered three two-week workshops to 58 elementary and middle school teachers in science, math, and technology using the Problem Based Learning Model. The 1995 program was designed with input from evaluations and recommendations from previous TEI participants and faculty. The TEI focused on Aviation and Aeronautics as the unifying theme. Four ASEE Fellows worked together to develop each two-week session.

Participants in the 1995 Teacher Enhancement Institute represented school systems where income levels are low, where the use of technology is limited, and student served tend to lack exposure to innovative instruction in mathematics and science. Seven states were represented which include Virginia, Kentucky, North Carolina, South Carolina, West Virginia, Maryland, and Utah. Washington, DC was also represented.

Four specific objectives were developed. After completing the requirements for the TEI, the participants should be able to: (1) Increase their content knowledge, particularly in aeronautics, science, math, and technology. (2) Design and implement lessons that use scientific inquiry through Problem Based Learning. (3) Demonstrate knowledge of instructional technologies, their uses, and applications to curricula. (4) Disseminate to their school communities the information acquired through the TEI.

Thirty percent of the program was devoted to the effective use of computer technology. Prior to the start of the program, participants were surveyed as to their experience and skill level with personal computers, software, and telecommunications. The survey results revealed that approximately 25% of the participants had no experience with computers, less than 20% indicated they were proficient, while the remaining 55% had some limited experience. Only 20% had used E-mail and fewer than 5% had used the World Wide Web.

The computing component, interwoven throughout the program activities, was designed to assist participants in developing technology rich skills. Survey results guided the methodology used which emphasized the use of the computer as a tool for collegial interaction and scholarly research. This practical, applications approach enable participants, with varying skill levels, to learn at their own pace and provided individual attention when needed.

SpaceLink, the NASA telecomputing service for educators, was the primary tool used in the technology component of the institute. The training focused on the use of SpaceLink and its many educational services, and Internet tools because of its universal, nongraphical link to any computer platform the participant may use at his or her school or home. All participants were given Educator Accounts to facilitate the use of E-mail, and access to the Internet and the World Wide Web using their SpaceLink accounts.

Classroom demonstrations used videotaped guides as handouts to support concepts presented followed by intensive hands-on activities. Each participant was assigned to an individual Power Mac networked workstation and introduced to the state-of-the-art, graphical, World Wide Web with the Netscape browser.

The methodology proved very effective in reaching the program's goals for technology integration by having the participants learn to use the computer as a tool for communication and research rather than teaching the use of any particular software application alone. However, because of the skill level of the majority of the participants, more hands-on computer time is recommended for future Teacher Enhancement Institutes.

Ocasio de Rodriguez, N. (December 1995). *Three Two-Week Teacher Enhancement Institutes: Design and Implementation*. In Surendra N. Tiwari and Deborah B. Young (Eds.) 1995 NASA-ODU American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program. Page 96.

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Participants were exposed to instruction by educators and NASA staff in theoretical and experimental foundations in problem solving. They also received hands-on telecommunication experiences, special presentations, and tours. Most of the hands-on activities were done in small groups called flight teams. Cooperative learning strategies were encouraged in discussions of various topics, resources research, and in the planning and presentation of lesson plans.

Authentic assessment techniques included portfolios, reflective journals, self evaluation, and oral and written presentations. Teachers were evaluated on the quality and level of their work in cooperative groups and individual participation.

Teachers' levels of confidence towards the use of technology, the teaching of science, math, and aeronautics were assessed using instruments developed by the TEI summer faculty members. An on-site evaluation regarding the impact of TEI on the participants was also developed. Data from these instruments will be analyzed and reported in a final report submitted to the director of the Office of Education.

Post-institute follow-up activities were programmed to ensure implementation of Institute strategies. It is expected participants will develop a unit plan that will be field tested in their classrooms during the 1995-96 school year. The effort should be a collaborative one between participants and the school community.

Presentation

Bartels, Bobbye Hoffman. (May 1996). Aeronautics Content Presented Through Problem-Based Learning Promotes the Integration of Mathematics and Science with Other Disciplines in Elementary and Middle School at 74th Annual Meeting of the Virginia Academy of Science, 21 - 24 May 1996 in Richmond, Virginia.

During Summer 1995, sixty elementary and middle school teachers participated in 2-week sessions as part of a Teach Enhancement Institute. The objective of the Institute was to increase teachers' knowledge of aeronautics, problem-based learning, and technology for implementation in classrooms. NASA aeronautics researchers made presentations to teach content, tours of NASA facilities demonstrated the scientific environment of aeronautics, hands-on experiments provided classroom-useful activities, and Internet exploration of aeronautics resources incorporated technology. By the end of the Institute, teachers' knowledge of aeronautics improved significantly, in their classrooms they incorporated aeronautics through problem-based learning, and they reported a greater awareness of aeronautics in the media. Teachers observed that implementations of aeronautics through problem-based learning produced highly motivated students and an effective medium for integrating science and mathematics with the other disciplines. (Funded by NASA-Langley Res. Ctr. Office of Education)